REMARKS/ARGUMENTS

The Pending Claims

Claims 1-5, 7, and 18-26 are pending and are directed to a flexible metal-clad laminate (claims 1-5, 7, and 19-25) and a flexible printed wiring board comprising the flexible metal-clad laminate (claims 18 and 26).

Amendments to the Claims

Claim 19 has been amended to recite that the average surface roughness Ra is not more than 0.4 μm, and the thickness of the metal foil is from 3 to 50 μm. The amendments to claim 19 are supported by the specification at, for example, page 12, lines 14-16, and page 33, lines 3-6. Accordingly, no new matter has been added by way of these amendments.

Summary of the Office Action

The Office has rejected claims 1-5, 7, and 18-26 under 35 U.S.C. § 103(a) as allegedly unpatentable over Watanabe et al. (U.S. Patent 3,936,575) in view of Frost (U.S. Patent 3,984,375) and Akahoshi et al. (U.S. Patent 4,970,107). Reconsideration of this rejection is hereby requested.

Examiner Interview

Applicants thank Examiner Kruer for the courtesies extended to Applicants' representatives John Kilyk, Jr. and Jason Miller during the telephone interview of May 9, 2005. The remarks set forth herein reflect the discussion during the Examiner interview.

Discussion of the Obviousness Rejection

With regard to the heat-resistant resin layer, the flexible metal-clad laminate of the invention is characterized by: (1) the heat-resistant resin layer has an N-methyl-2-pyrrolidone-insoluble content (hereinafter referred to as "insoluble content") of at least 1%, i.e., the resin layer has a specific crosslinking degree, and (2) the average surface roughness Ra of the surface of the heat-resistant resin layer which is in contact with the metal foil is not more than 0.4 μm. With these properties, curling in the flexible metal-clad laminate can be prevented, even though the thickness of the metal foil is as thin as 3 μm to 50 μm and the metal-clad laminate is prepared by applying a solution to a substrate and drying the solution (see Table 2 on page 48). Since the average surface roughness Ra of the surface of the heat-resistant resin layer in contact with the metal foil is 0.4 μm or less, the heat-resistant resin film layer does not curl even after the removal of the metal foil by etching (see page 33, lines

3-6, and page 46, lines 21-25). The present invention has successfully achieved prevention of curling of the laminate, as described above, as well as in the heat-resistant resin layer after the removal of a metal foil by etching, due to the specific insoluble content (an index showing the degree of crosslinking in a resin) and the average surface roughness Ra of the heat-resistant resin layer of the flexible metal-clad laminate.

Watanabe et al. discloses (1) a flexible metal-clad laminate in which an epoxy resin is laminated on a metal foil, and (2) obtaining the laminate by impregnating a fibrous substrate with an epoxy resin, and bonding the impregnated base to a metal foil under heat and pressure by means of a roll-laminator (see col. 1, lines 17-4, col. 3, lines 28-35, and col. 13, lines 9-46). Although Watanabe et al. discloses using an epoxy resin, Watanabe et al. neither teaches nor suggests the insoluble content of a polyamide-imide resin.

Frost discloses various examples of polyamide-imide resin structures and employing the polyamide-imide resin as an electrically insulating wire material. Frost discloses using a polyamide-imide resin; however, Frost nowhere suggests adjusting the insoluble content of the polyamide-imide resin to 1% or higher, nor suggests that such an insoluble content is effective for preventing curling in the flexible metal-clad laminate as described below in detail.

Akahoshi et al. discloses (1) a multi-layered wiring circuit board, (2) a multi-layered wiring circuit board in which the bonding strength between a resin and a copper layer is improved by forming knife-shaped elongated projections on a copper surface that is in contact with a prepreg layer, and (3) a substrate with a copper foil surface and prepregs that are obtained by impregnating a glass cloth with a resin comprising, for example, polybutadiene and drying the cloth, in which multiple substrates are subsequently laminated under heat (see col. 6, line 49, through col. 7, line 4). Akahoshi et al. does not disclose the claimed polyamide-imide resin or adjusting the insoluble content of the polyamide-imide resin to 1% or higher.

The Examiner apparently concludes that the lower limit (i.e., 1%) of the insoluble content specified in the pending claims is an extremely low amount and that the resin of Frost inherently has an insoluble content of 1% or higher. However, the fact that the insoluble content is 1% in the present invention implies that the degree of crosslinking of the polyamide-imide resin is significantly high.

More specifically, in order to achieve an insoluble content of 1%, it is necessary to bond an extremely large number of molecules to form a crosslinking structure (three-dimensional network structure). In other words, comparing a resin with an insoluble content of 0% and a resin with an insoluble content of 1%, the former resin would essentially have no formation of a crosslinked structure, and the latter resin would have a significantly high degree of crosslinked structure. In this regard, enclosed is the English translation of "2.2

Macrogelation" of "Soichi MUROI and Hidekazu ISHIMURA, 'Guide for Epoxy Resin (Nyuumon Epoxy resin)' (1986)". The section "2.2 Macrogelation" describes the relationship between the progress of gel formation (i.e., crosslinking) and the generation of a solvent-insoluble portion. In Fig. 5.23, the horizontal axis represents the curing time (curing period from the beginning of the curing reaction), and the vertical axis represents the varying proportion of the solvent-soluble portion and the solvent-insoluble portion in the resin. Fig. 5.23 shows that the yield of the solvent-insoluble portion does not increase for a certain period of time after the curing reaction is initiated, and the insoluble portion (i.e., gel formation) is then first generated when crosslinking formation advances to a certain degree and then the insoluble portion starts to increase (P_{cr} in Fig. 5.23). Fig. 5.24 schematically shows the course of aggregation and unification of microgels with time, resulting in formation of a gel polymer (i.e., crosslinked resin with a three-dimensional network structure). After the crosslinking reaction was initiated, a microgel is generated at a theoretical gel point. At this point, a gel (insoluble portion) is theoretically generated; however, as described above with reference to Fig. 5.23, the yield of the insoluble portion is zero for a certain period of time after the initiation of the crosslinking reaction (i.e., insoluble content of 0%). The aggregation and unification of microgels significantly advance, and reach a physical gel point (P_{cr} in Fig. 5.23), and then an insoluble portion actually begins to be generated (i.e., insoluble content is greater than 0%). As can be seen from the foregoing, a resin with an insoluble content of 1% or higher shows that the crosslinking reaction is considerably advanced.

This is also clear from the examples in the present specification (see, for example, Table 2). For instance, the flexible metal-clad laminate of Example 1 with an insoluble content of 2% did not curl. In contrast, the flexible metal-clad laminate of Comparative Example 1 with an insoluble content of less than 1% sharply curled and had a radius of curvature of 15.0 cm. Thus, an "insoluble content of 1% or higher" is of significant importance.

In the enclosed Rule 132 Declaration, Example X of Frost was replicated so as to demonstrate that the insoluble content of the resin layer obtained thereby is less than 1% and that curling occurs in a flexible metal-clad laminate manufactured using a resin with an insoluble content of less than 1%. As such, the heat-treatment was carried out at the highest temperature (200 °C) and for the longest period of time (several hours), as described by Frost. More specifically, the heat treatment time in Frost is described as "several hours," and, therefore, two-hour and ten-hour heat treatments were conducted.

In order to confirm whether or not the flexible metal-clad laminate curls, the polyamide-imide precursor solution obtained in replicated Example X was applied to copper foils, and the heat treatment was conducted at 200 °C. As seen in the Rule 132 Declaration,

all the resin layers obtained by Example X were confirmed to have an insoluble content of 0%, and therefore did not have an insoluble content of 1% or higher, as required by the pending claims. It was also confirmed that the radius of curvature of a curl of the flexible metal-clad laminates obtained was 7.0 mm, and therefore the laminate sharply curled.

In view of the foregoing and contrary to the Examiner's assertion, the resin of Frost does *not* inherently have an insoluble content of 1% or higher.

The Examiner considers that the surface roughness of a copper layer described in Akahoshi et al. is equivalent to the surface roughness of the resin film layer of the invention. Akahoshi et al. teaches that the surface roughness of a *copper layer* is from 0.1 to 1.0 μm due to etching (col. 1, lines 34-46) so as to improve adhesion. Nowhere in the Akahoshi et al. disclosure is there a discussion of the roughness of a heat-resistant *resin film layer* as recited in the pending claims. The surface roughness of the resin layer is *not* the same as the surface roughness of the substrate layer (i.e., a metal foil). One of ordinary skill in the art would recognize that it would not be possible to obtain a resin layer with the surface roughness required by the pending claims by merely replicating the surface roughness of a foil layer. Accordingly and contrary to the Examiner's assertion, Akahoshi et al. does not teach the roughness of a resin layer and does not remedy the deficiencies of Watanabe et al. and Frost.

In the flexible metal-clad laminate of the invention, the average surface roughness Ra of the surface which is in contact with the metal foil of the heat-resistant resin layer is 0.4 μm or less, which can prevent the curling in the resin film layer after removal of the metal foil by etching. More specifically, the resin film layers of Examples 1 to 12, which had Ra of 0.4 μm or less, were flat even after the removal of the metal foil by etching. In contrast, the resin film layer of Comparative Example 5 with Ra of 0.53 μm curled and had a radius of curvature of 3 cm (page 46, lines 21-25).

As described above, the cited references, even in combination, do not disclose all the elements of the pending claims, particularly (1) the insoluble content is at least 1% (i.e., the resin layer having a specific crosslinking degree), and (2) the average surface roughness of the surface which is in contact with the metal foil of the heat-resistant resin layer is 0.4 μm or less. Moreover, there are unexpected benefits attendant the foregoing elements of the pending claims. As a result, the cited references cannot be considered to render obvious the flexible metal-clad laminate of the pending claims. Accordingly, the obviousness rejection of claims 1-5, 7, and 18-26 based on the combination of the Watanabe et al., Frost, and Akahoshi et al. references should be withdrawn.

Conclusion

If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

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